Part 1: GIS Data from the Web: Downloading and Projecting Digital Elevation Models (DEM) and BTS Road data

1. Introduction

a. GIS tools allow us to not only visualize/querry existing datasets but to create our own. In this exercise we will learn to download and manipulate datasets available free over the web. In Part 2, we will use these data sets will as a base map on which we will plot our own data. This exercise will teach us many of the fundamental skills necessary to make basic maps using GIS tools.

b. You will download Digital Elevation Models, and the digital vector road data from the USGS website: http://seamless.usgs.gov.

c. **Projections** - Every spatial dataset is projected in some manner, to transfer the geographic coordinates of latitude and longitude on the three-dimensional earth to X and Y coordinates on a flat piece of paper. When using a dataset, we need to know what projection it is in, so that it can be properly aligned with other datasets. All the data in a GIS data view must be in the same projection in order to line up properly with all the other datasets. In ArcGIS these tasks are often done in the background, so the user does not have to worry about them. ArcGIS will use the projection of the first dataset loaded to set the projection of the view. It will then re-project each dataset on the fly to match that projection, so long as the datasets have a projection defined. If not, it will guess at what projection the data is in.

2. Data and Software

a. For this part of the lab/homework you will download the necessary data (DEM raster data and Roads vector data) from the web, as detailed in the following instructions.

b. All of this exercise can be done in the ArcMap, including ArcToolbox, and ArcCatalog modules of the ArcGIS Desktop. Each application can be found in the Start menu, under: Start >> All Programs >> ArcGIS, except ArcToolbox, which is accessible from ArcMap.

3. Downloading a Dataset

a. *(you should be using Mozilla Firefox as your browser. Internet Explorer won't work.)*

b. **Background**

i. For this exercise we will use elevation data from the National Elevation Dataset (NED). The NED is a collection of elevation data which covers the entire United States. It has been processed to correct discrepancies, fill holes, match the edges of source datasets, and fill slivers of missing data. More information on the NED can be found at http://ned.usgs.gov//About.asp.

ii. The NED is now available through "The National Map Seamless Data Distribution System" from the USGS. The website for this seamless national map is: http://seamless.usgs.gov. The National Map website makes available a number of datasets, as listed below. The seamless data distribution system allows users to select an area of the country or the world, and to download seamless data for that entire area as one dataset. The system allows for data delivery via free web downloads (with size restrictions), or via CD-ROM media.

iii. The National Map Seamless Data Distribution System data sets:

1. Toogtaphy, Structures, Transportation, Boundaries, Hydrography, Orthoimagery, Land Cover, etc. (NED, NLCD, SRTM, etc)

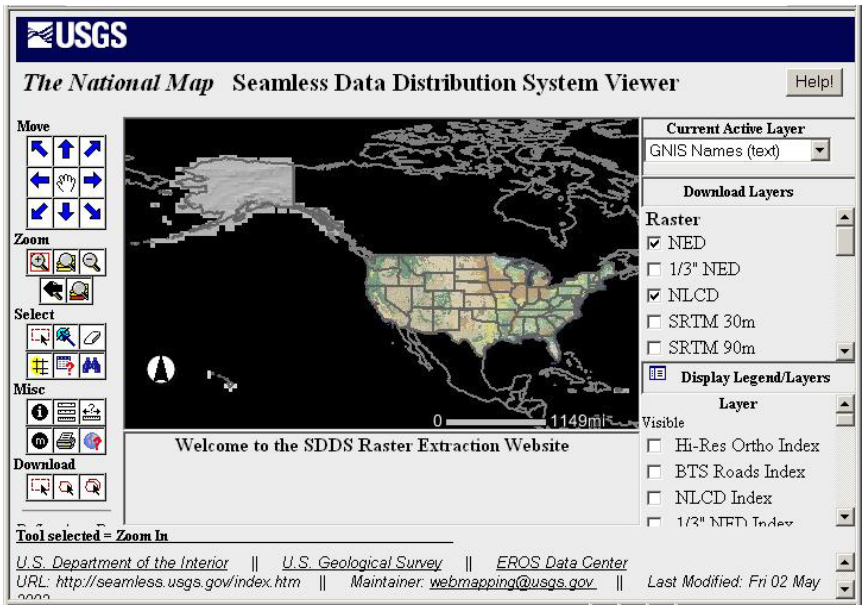
iv. Some areas of the United States have elevation data available in rasters that have cells that are 10 meters by 10 meters (NED 1/3) while the rest of the country is available at 30 meters by 30 meters (NED 1/3). The rest of the world is available at 90 meters by 90 meters (SRTM 1 arc second). In all cases a single elevation represents the entire cell.

v. You will also download a streets database for the same area - the Bureau of Transportation Statistics (BTS) roads network.

c. **Downloading the datasets**

i. Go to The National Map website (http://seamless.usgs.gov), and click on the link to: "View and Order Data Sets - United States Viewer".

ii. An ArcIMS internet mapping site will open up (see image below), with a view of the United States, and the available NED shown. You can use the tools on the left to move around the map, zoom in and out, and select features like within ArcMap. On the right are two lists of data layers. The top one is download layers. The layers selected in this list will be downloaded when you select an area with one of the download tools. The bottom list is the visible layers list, and layers selected from this list will be visible in the viewer. In order to view changes in your selections, you must click the "Refresh Map" button at the bottom of the list (scroll down).



iii. Use the tools to zoom-in and find an area that you are interested in, such as your home, where you like to vacation, or some place you have always wanted to visit. Try to choose an area that has some elevation differences... a flat floodplain won't be a very interesting elevation dataset. Also, if you can, pick an area with features that you will be able to recognize, so that you can see the effects of projection more clearly. The area should be somewhere around a scale of 1:60,000 (shown in the upper right corner of the window), since we don't want too big a dataset for this exercise.

iv. Once you have found an area you like, make sure that ONLY (Elevation/NED 1/3") and (Transportation/BTS Roads) are selected in the Download Layers list.

v. Use the "Select By Rectangle" Download tool to select the area for which you want to download data.

vi. When you release the button, a new window will appear, and after a moment of processing, you will get a SDDS Request Summary Page containing links to download your selected data layers. By default, your elevation data should be in ArcGrid format and the roads will be a shapefile (a vector format native to ArcGIS). If you wanted to change the format of your data, the format of the metadata, the datasets selected, or other options, you can use the Modify Data Request Button. If you have do this, Be sure to go to the bottom of the modify page to "Save Changes".

vii. Click on the "Download" link next to the NED and roads datasets. When the data is extracted, select "Save" and save the Zip file it to a new directory that in the folders that you have access to.

viii. Use Winzip to extract the files from the .zip file that you downloaded. Save to the folder you already created. The naming of the files is tricky (purely numeric), so keep track of which is the roads and which is the elevation data.

4. Examining the Data

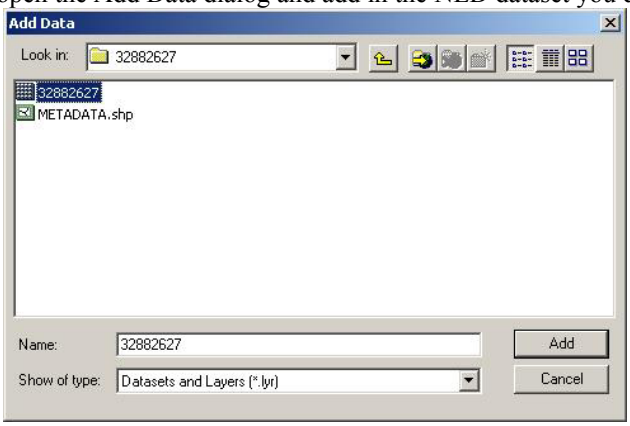
a. Open ArcCatalog and navigate to your newly downloaded NED dataset. You will see a grid (the actual data) and a shapefile called METADATA. This file contains polygons depicting the original DEMs from which your dataset was assembled.

b. Select the grid dataset and click the Metadata tab to view the metadata for the NED grid. Find the section on projections and coordinate systems. What projection is it in?

c. Close ArcCatalog and open ArcMap with a new, empty map.

d. Before loading any data, view the Data Frame Properties (under the View menu). Go to the Coordinate System tab. Under Current coordinate system, It should say "No Projection", indicating that no projection is defined for the data view. Close the Data Frame Properties Dialog.

e. Now, open the Add Data dialog and add in the NED dataset you downloaded.

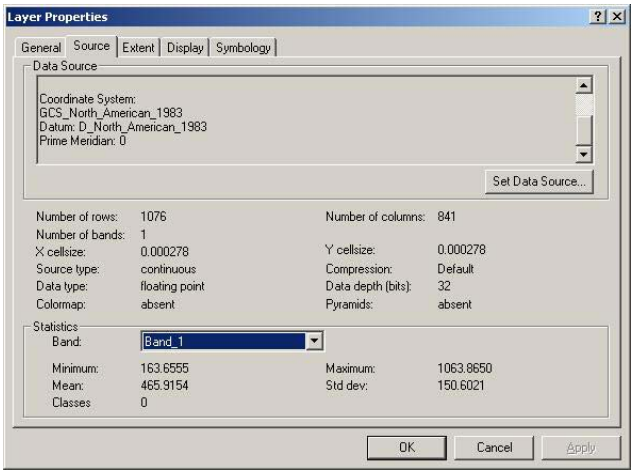


f. The dataset should appear on the Layers list.

g. Go to the new dataset's Layer Properties dialog (Right-click it's name and select Properties from the context menu).

h. Go to the Source tab and scroll down the top box titled "Data Source" to see the Coordinate System information.

i. The Coordinate system should show up as "GCS_North_American_1983", as shown below:



j. Since there is no further projection information, this indicates that the data is in the simplest type of Latitude/Longitude projection, the "Geographic Coordinate System"

(GCS). The Datum used is the North American, 1983 datum (NAD83), which is pretty standard today, although some datasets are still in the older 1927 datum (NAD27).

k. Close the Layer Properties Dialog and go to the Data Frame Properties dialog again. Look at the Coordinate System information again, and note that the Data Frame view has been set to GCS_North_American_1983, to match the data. Close the Data Frame Properties dialog.

l. Don't forget to Save your work.

5. Project the Data

a. Open the ArcToolbox from within ArcMap by clicking the red toolbox icon.

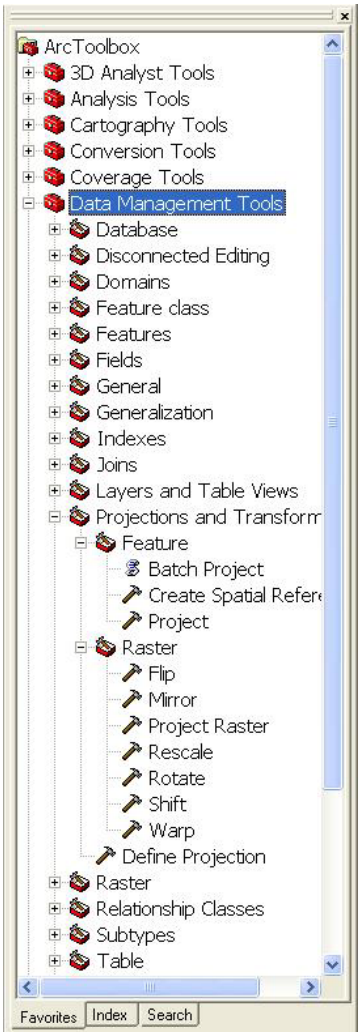
b. Since you have found that the dataset you downloaded already has a projection defined (GCS - NAD83), you do not need to define a projection, but can simply project it into another projection .

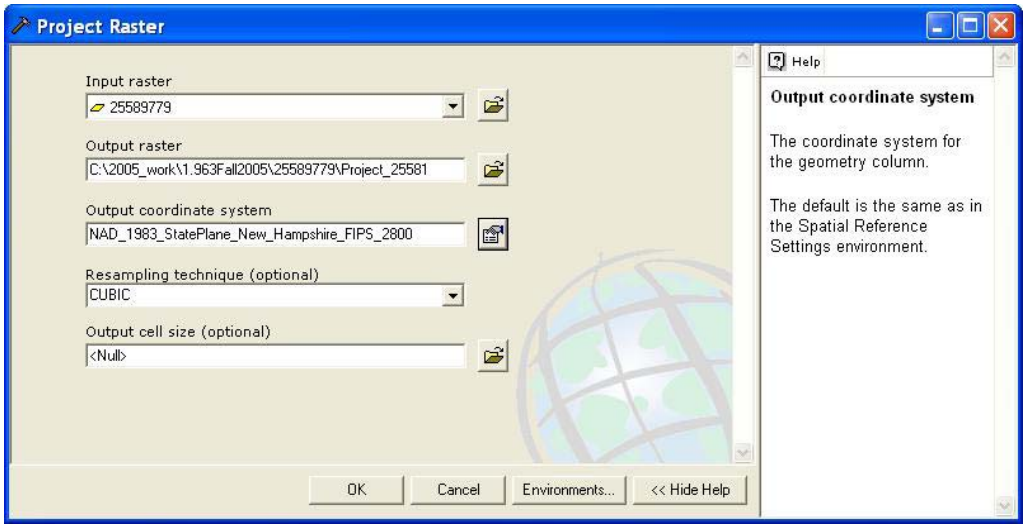
c. **Side Note**: If you ever come across a dataset that has no projection defined, it is likely that it may be in a GCS projection. Try defining it as GCS, and lay it over some data of a known projection in the same geographic region and see how it lines up. Datasets with no projection defined might also be in a State Plane projection, especially if they are state level or smaller data, so try that next.

d. In ArcToolbox, go to Data Management Tools >> Projections >> Raster and look at the available tools. There should be two sets of projection tools, one for features (vector data (Features) - points, lines, and polygons) and one for raster data, like DEMs.

e. Since we want to re-project a grid with a projection already defined, select "Project Raster " and double-click on it to open the wizard.

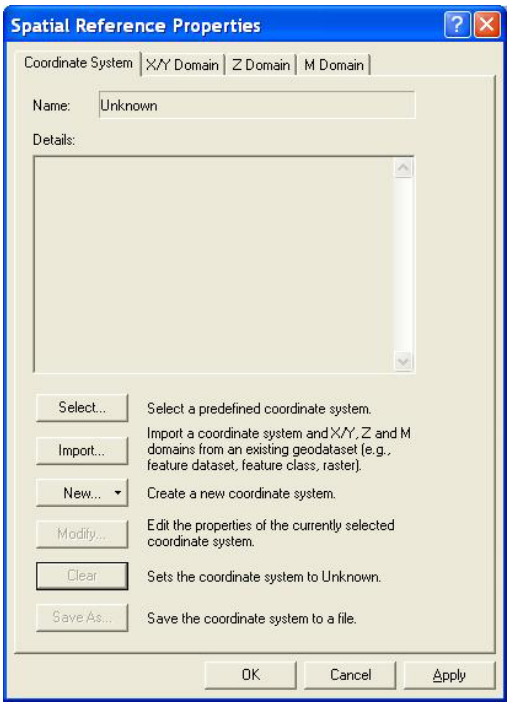
f. In the next window, use the browse button under Input Raster to find and select your NED dataset.





g. Be sure to name your output raster something distinctive and unique

h. Click the button next to the 'output coordinate system' and designate whether you want to select a predefined coordinate system or import one from another dataset. (See figure: Spatial Reference Properties)



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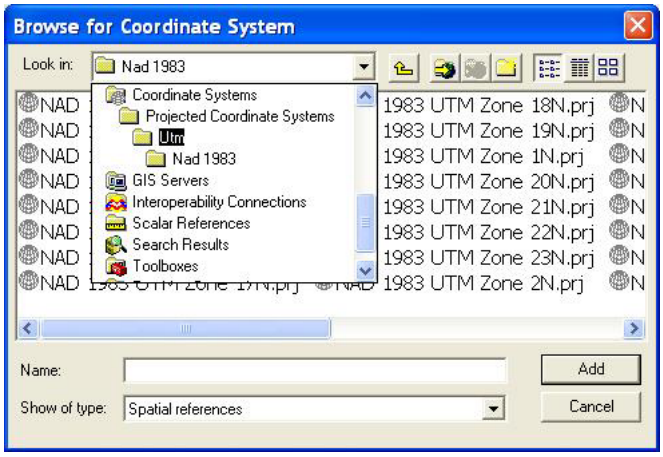
i. For the 'Select' option:
   i. This gives you the opportunity to browse through Geographic (latitude and longitude) and projected (State Plane, UTM) coordinate systems.
   ii. Select the UTM coordinate system. Click Next to continue and navigate to Projected Coordinate Systems, UTM, and NAD 1983 and then choose the zone that you retrieved data for, using the map of zones located at http://rockyweb.cr.usgs.gov/outreach/gps/UTM_Zones_USA48.jpg.



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j. For the 'Import' option
   i. use the file browser to locate a file that you know is the same coordinate system that you want to project your data to. When you select the particular dataset, you will see the projection information displayed in the 'Spatial Reference Properties' window

k. I recommend *cubic* resampling as the other types can create artifacts in your elevation or slope data. Leave the output cell size as it is.

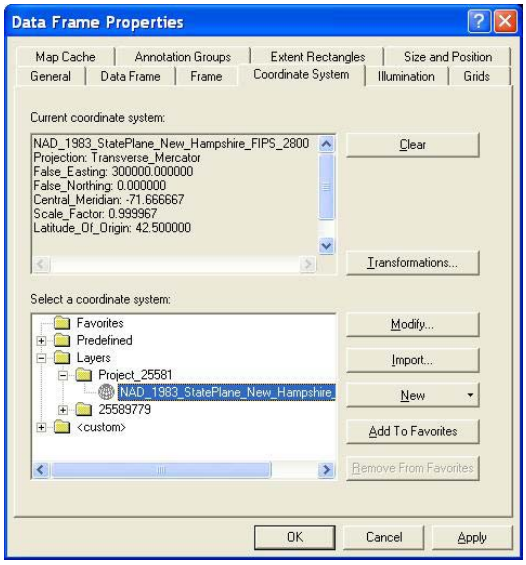
l. When all is ready, click OK to run the wizard.

m. Wait for the "Processing..." window to close. Your data has been projected and a new dataset created. It is automatically added to your map and it won't be evident that it has been, unless you look at the Table of Contents. That is because the new layer, the projected DEM, has projection information stored within it and the program projected the data to the projection of your original data (Geographic).

n. Now, follow the same procedure but for the BTS Roads data. Because the Roads data is a shapefile (vector data), you will need to use a different part of the Projections and Transformations toolbox. This time go to Proj. and Trans. --> Feature --> Project. Because you now have a data set in the appropriate projection, you can use the 'Import' function in the 'Spatial Reference Properties' window. Select the new projected DEM and you are ready to fill in the rest of the projection data as you did for the DEM.

6. Changing the projection of a map document and displaying your data

a. The projection is changed by changing the data frame properties. The data frame is the map area of ArcMap. To change this, click on the View menu and then click on Data Frame Properties. You should see a form like this one:



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b. You can change your projection to any of the available projections, or to the projection of any of the layers in your map. In this case, I navigated to the layers list, clicked on my new projected layer, and then chose its projection. Click ok. You should see the map change somewhat. If you can't see your data, right click on the name of the new, projected grid and then click on Zoom to Layer.

c. Add the UTM-projected roads layer shapefile. This will appear on the map in the correct location. The old, GCS-projected file would also display in the correct location because Arc GIS is making the transformation for your display. BUT, when we create data in a GIS, it is always important to make sure that all datasets are in the same projection. This is important when we share data with other people or move data to other applications (like ArcPad) that does not do projections on the fly like ArcMap.

d. Remove all of your old GCS data from the legend as you no longer need it because it is now available in the correct UTM projection.

e. Try labeling the roads layer. Right click on its name then click on Label Features. The roads will be labeled with the street names. If you can't see all of the street names, zoom in so that there is more space to draw the labels.

Congratulations! You are done with Part 1.

You are now ready for PART 2 of the lab, 'Creating your own data.'

initially created by Christiaan Adams.
updated 9/26/05 - Daniel Sheehan.
minor revisions and transformation from .html to .doc and .pdf 10/11/05 - ben crosby.

Introduction

Congratulations! You have now made a simple GIS project containing a few layers that you downloaded of the internet. In this portion of the exercise, you will make some changes to beautify your map and then create point, line and polygon shapefiles. Point shapefiles could denote such data as: locations of friend's houses or locations of favorite stores. Line shapefiles could denote routes such as the route you took to school, the route you took to the store, etc. Another line shapefile could denote creeks you played in or railroad tracks or gang turf-boundaries. The polygon shapefiles could show areas such as your extended neighborhood or commercial districts or discrete housing developments. Be creative, but keep in mind that each shapefile should be of a coherent theme so that they contain comparable data.

When you are picking topics to generate a shapefile for, make them broad so that they will contain multiple features that you can categorize multiple ways. For example, one of the point shapefiles could be called 'friend's houses.' In this shapefile, each of the points that you create on the map can have multiple attributes: address, first name, last name, house color, age during friendship, pet type, etc. The idea is to have multiple attributes that can be used to decide symbology.

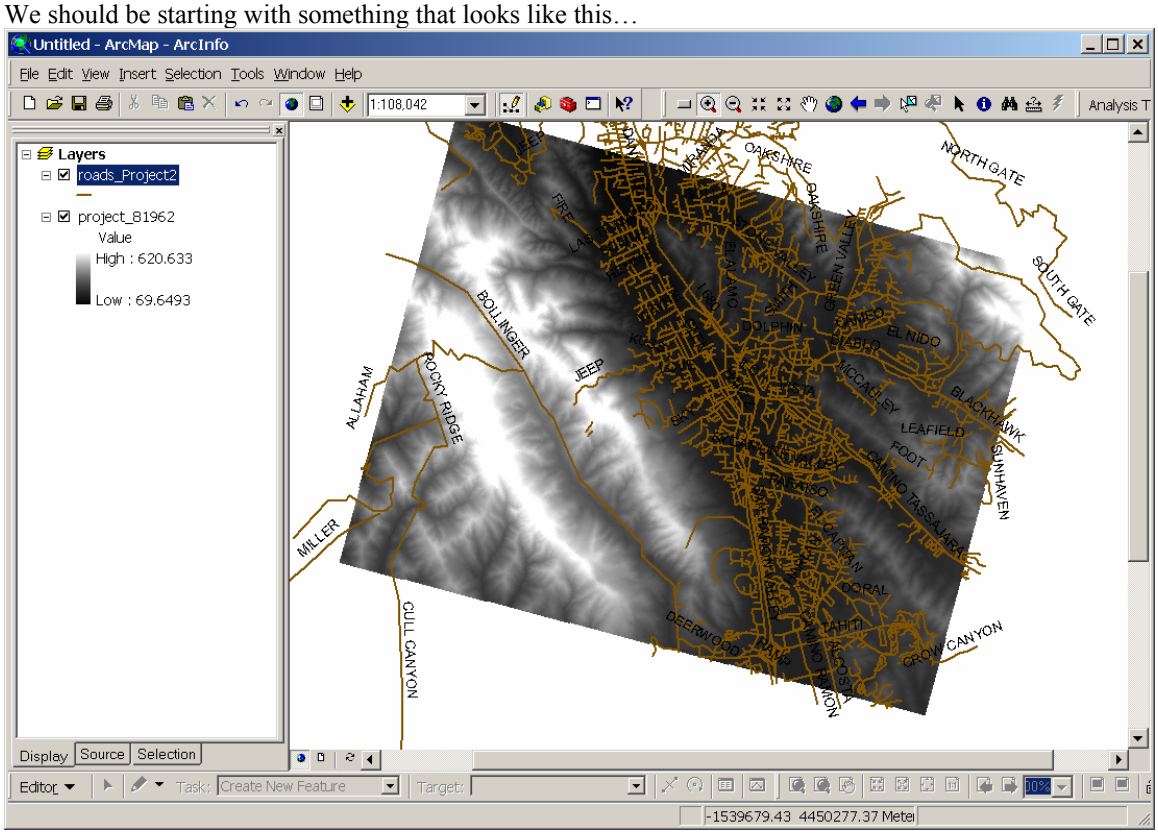
This is an exercise, and I have no interest in stealing your identity or your childhood friend's pets. You are welcome to make the data up (this will be the **only** time that this is allowed!), but think about the map you are making and ask whether or not it makes sense. This exercise is intended to build your skills in creating and editing shapefiles…don't let the soft draw of nostalgia slow you down or compromise your capacity to create rich and well attributed data.

Materials

GIS-ready computer Internet connection Memories of home

A completed GIS project with roads and topography from your hometown.

We should be starting with something that looks like this…



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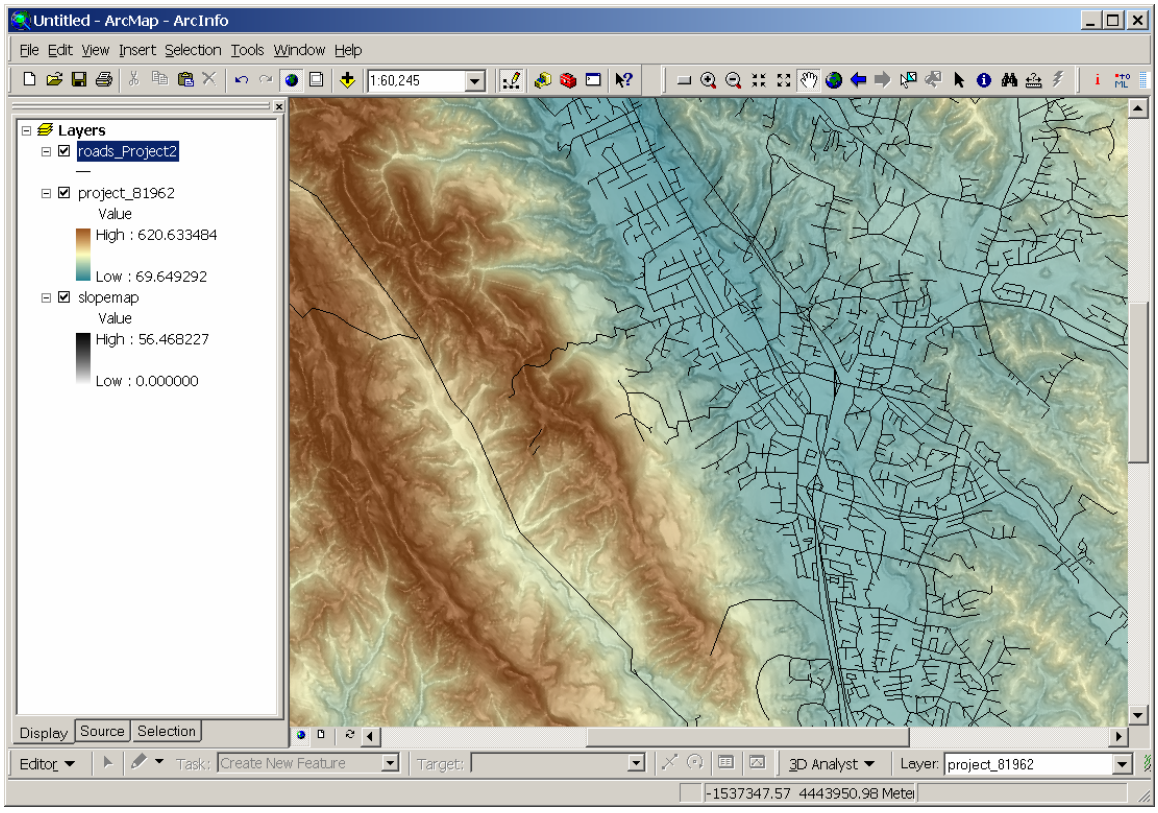
Improving the readability of our map.

Now that your DEM data are in a projection that is in meters (UTM) rather than degrees (GCS), you can run calculations on the elevation data to make other raster data files that help you visualize the topography. Let's start by making a slope map. Follow the instructions given in the file "make_slope.pdf" linked in the Tools section of this course.

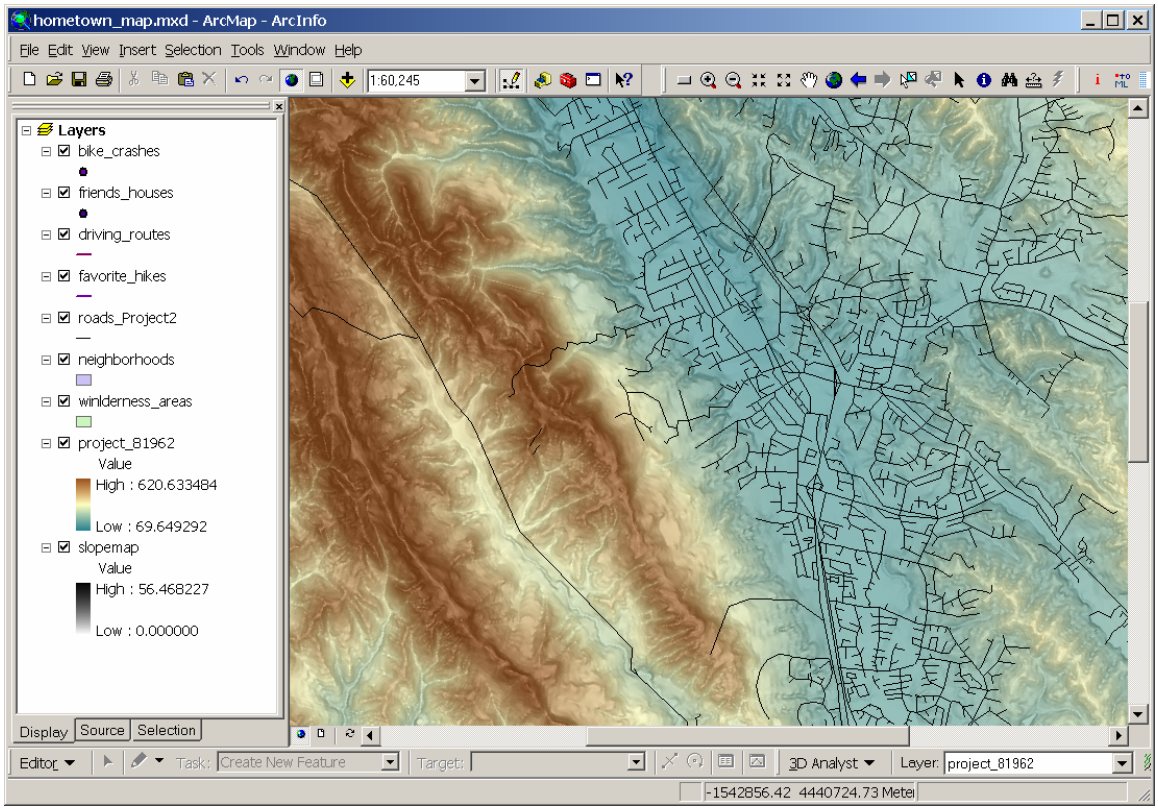
Now that you have made a new vector file it will display above the elevation data in the legend bar on the left side of the screen. You will want the elevation data to be on top so drag the elevation layer up and drop it above the slopemap layer. Now click properties for the elevation data and select the "display" tab. Change the 'transparent' field from 0% to 30%. This will make the DEM see-through. Now click the 'Symbology' tab and change the color ramp to something cool and colorful. I like the color ramp between brown and teal blue personally, and I invert it so that the brown is at the high elevations…this choice is up to you. Click 'OK' and you should now see your colored DEM with shading from the slopemap beneath. Save your work. Now we have a good looking map!



Creating your own shapefiles

Using ArcCatalog (accessible from the icon that looks like a yellow filing cabinet on the toolbar), we will now create 2 point shapefiles, 2 line shapefiles and 2 polygon shapefiles. Once ArcCatalog is open, find your way to the directory where you have stored your roads data (it will be something like… langtang/D2/12.114_class/students/your_name). When you create them, name the shapefiles as descriptively as possible. Also when we create the shapefile we are going to use the Import button to define the projection to be the same as the DEM or the BTS roads that we projected to UTYM.
Go to "make_shapefile.pdf" in the Tools section to see the tutorial describing how to create new shapefiles:

Once you have created all six of your new shapefiles, load them into ArcMap.



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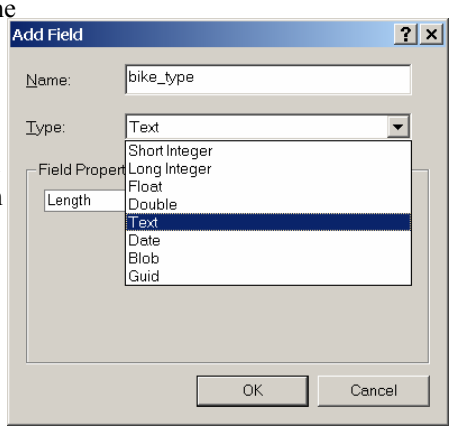
Adding attributes to your shapefiles

Once you have created all six of your blank shapefiles, you are ready to open ArcMap and begin adding data to your shapefiles. Like you did in the first part of this lab, you will use the 'add data' button, (the yellow plus symbol). As the shapefiles have no data yet, you will see no new points, lines or polygons, but your will see the layers in the legend. Notice that the load in so that points are on top, then lines, then polygons. This helps with layer visibility so one layer does not obscure the other.

Now that you have added the files to the map, we should prepare each file to have multiple attributes. For example, in my bike_crashes point shapefile, I would like to include information regarding the year, the bike-type, the personal-injury, the bike-damage, the cause, etc… This information can be attached to each of the points that I create. This information is considered the 'attributes' of the point. Lines and polygons can have attributes as well and the method for creating them is the same as for points.

- To create attributes in a shapefile, right click the title of the layer you want to add attributes to, then select 'open attribute table.'
- The headers that you see are the names of the columns of data that you will create. Values for the columns FID, Shape, and ID will be filled in automatically by ArcMAP.
- To create your own columns that you will later fill in with your values, click on the 'Options' button in the lower right corner of the Attributes window and select 'Add Field…'
    - In the window that opens give a short name to your attribute (no spaces or dashes) and specify which "type" of data it is:
    - <u>The types are as follows:</u>
        - short integer — an integer between -32,000 and +32,000
        - long integer — an integer between -2 billion and +2 billion
        - float — between -3.4E-38 to -1.2E38 for negative numbers and 3.4E-38 to 1.2E38 for positive numbers with seven significant digits
        - double — between -3.4E-38 to -1.2E38 for negative numbers and 3.4E-38 to 1.2E38 for positive numbers with fifteen significant digits
        - text — type what you want, must specify the field length (# of chars.)
        - date — mm/dd/yyyy hh:mm:ss and a specification of AM or PM
        - blob — binary large object (we will not use this, embedded data)
        - guid — Global identifier field



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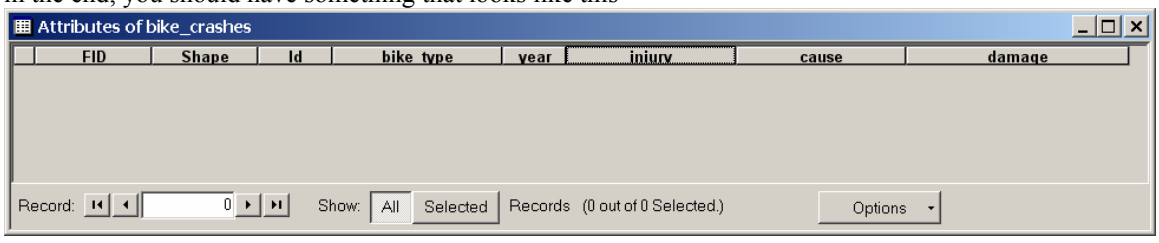
- If you create a field and want to modify it…sorry, you can't. Delete it by right clicking on the column name and selecting 'delete field'
- **Add three or so new fields to each of your six shapefiles. be certain to name them correctly and specify the correct 'field type'**

in the end, you should have something that looks like this



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Adding data to your attributed shapefiles

Once you have created all six of your attributed (but still blank) shapefiles, you are ready to use the Editor toolbar to create the actual points, lines and polygons.

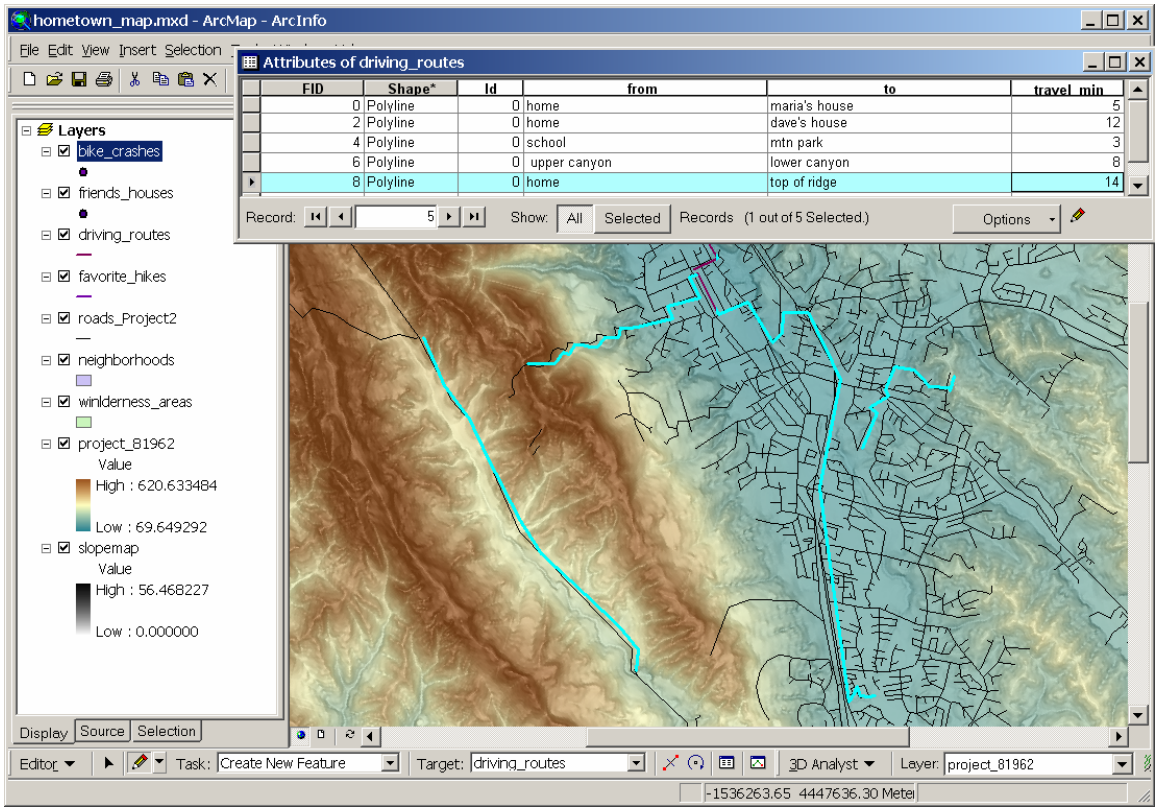
Again, we will use the online tutorial to get us started. This one is about starting an editing session. It is in "editingvectors.pdf" in the Tools section.

Now that we have an editing session started and have selected the correct shapefile as the target, we can begin adding data. The one last thing to do is to right click on the shapefile in the legend and select 'open attribute table.' This is the easiest way to watch the points or lines you create get added into the shapefile and to add specific data to the attributes of that point or line.

The tutorial to help with drawing lines (the same process applies to points and polygons as well) is available in "draw_line.pdf" in the Tools section.

As you complete each individual line, add the attribute data. It is easier to do this as-you-go rather than attributing at the end when you are not sure which line or point corresponds to which row in your sheet. MAKE SURE YOU SAVE YOUR WORK FREQUENTLY, as ArcMap can crash during editing and if you have not saved your data, you WILL loose it.

Once you have finished adding 4-5 objects (points, lines, polygons) to the shapefile you are editing, save your edits (using the editor toolbar pull-down menu), and specify a new target and begin adding data and attribute data to the next shapefile. Remember to save as you go. By the time you have done this for all 6 shapefiles, you will be a wiz!



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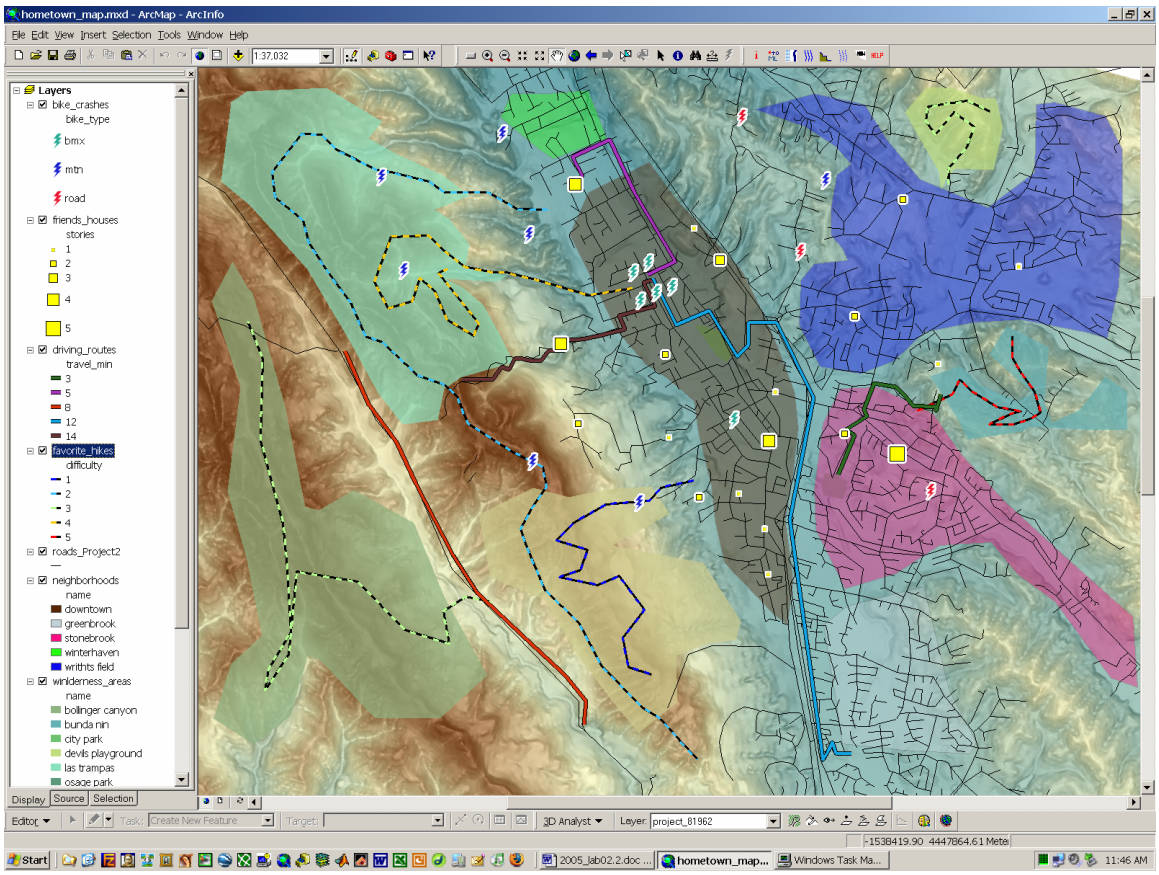
Displaying your data using your attributes to dictate symbology

Now that you have created all this attributed data, you can use those attributes to make a smart looking map where the symbols/colors/etc for each item can be reflective of the attributes of that particular point, line or polygon.

As we did with changing the way the DEM's data was displayed, we will change the way each of our shapefiles are displayed by right clicking on the name in the legend and selecting 'properties'. Go to the symbology tab and select 'categories' on the left hand side of the properties window. Then select the attribute that you wish to use to display the data in the 'Value Field' pull down menu. Then click add all values to gather the different values you used. (for example, I have selected bike_type for my bike_crashes point shapefile). Tweak the settings so that each of your layers displays the way you want it to. For example, feel free to change the transparency of your polygons so you can see the topography below them. As well, if you want to change the properties of all your symbols in a particular shapefile, right click in the window where all the different attribute values are displayed and select something like 'change properties for ALL values.' Play around with the display options and find how to best show your data. This is one of the great advantages of working with GIS. If you have questions about this step, please let me know, I'm right down the hall or reachable via email.

When you have finished, send me an email and I will be able to look over the map you made as you have saved the ArcMap document (and all the related files) onto Langtang in the folders I prepared.



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